# Final notebook with final function1 and model performance check function2

## model deployed in heroku

https://healthcare-prediction.herokuapp.com/

In [1]:

```
import pandas as pd
import numpy as np
import matplotlib
matplotlib.use(u'nbAgg')
import matplotlib.pyplot as plt
import warnings
warnings.filterwarnings("ignore")
import seaborn as sns
from collections import Counter
from sklearn import preprocessing
from sklearn.linear_model import LogisticRegression
from sklearn.model_selection import RandomizedSearchCV
from sklearn import metrics
from sklearn.metrics import roc_curve, f1_score, confusion_matrix
from prettytable import PrettyTable
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import RandomForestClassifier
from xgboost import XGBClassifier
import joblib
from tqdm import tqdm
```

In [2]:

```
X = ['Test_Inpatientdata.csv',
     'Test_Outpatientdata.csv',
     'Test_Beneficiarydata.csv',
     'Test.csv']
```

In [22]:

```
test_inpatient = pd.read_csv('Test_Inpatientdata.csv')
test_outpatient = pd.read_csv('Test_Outpatientdata.csv')
test_bene = pd.read_csv('Test_Beneficiarydata.csv')
test_data = pd.read_csv('Test.csv')
```

In [11]:

```
def final(X):
    """ function take raw input and then preprocess,featurize and trained """
    test_inpatient = X[0]
    test_outpatient = X[1]
    test_bene = X[2]
    test_data = X[3]

    inpatient = pd.read_csv(test_inpatient)
    outpatient = pd.read_csv(test_outpatient)
    beneficiary = pd.read_csv(test_bene)
    test = pd.read_csv(test_data)

    final_data = pd.merge(inpatient, outpatient, left_on = [ col for col in outpatient.columns if c
ol in inpatient.columns], \
                      right_on = [ col for col in outpatient.columns if col in inpatient.columns], ho
= 'outer')

    final_data = pd.merge(final_data,beneficiary,how='inner',on='BeneID' )
    final_data = pd.merge(final_data,test,how='outer',on='Provider')
    print('all file merged...')
```

```
    ## pre processing
    ## removing ClmProcedureCode_5, ClmProcedureCode_6 as it has all null

    final_data.drop('ClmProcedureCode_5',axis=1,inplace=True)
    final_data.drop('ClmProcedureCode_6',axis=1,inplace=True)

    ## remove as it has all value as same

    final_data.drop('NoOfMonths_PartACov',axis=1,inplace=True)
    final_data.drop('NoOfMonths_PartBCov',axis=1,inplace=True)

    ## replacing null with 0

    colFillna = ['ClmDiagnosisCode_1','ClmDiagnosisCode_2',
             'ClmDiagnosisCode_3','ClmDiagnosisCode_4',
             'ClmDiagnosisCode_5','ClmDiagnosisCode_6',
             'ClmDiagnosisCode_7','ClmDiagnosisCode_8',
             'ClmDiagnosisCode_9','ClmDiagnosisCode_10',
             'ClmProcedureCode_1','ClmProcedureCode_2',
             'ClmProcedureCode_3','ClmProcedureCode_4',
             'DiagnosisGroupCode','ClmAdmitDiagnosisCode','DeductibleAmtPaid']

    ## RenalDiseaseIndicator has y and 0 - replacing with 1 and 0
    final_data[colFillna]= final_data[colFillna].replace({np.nan:0})

    ## ChronicCond has 2 and 1 - replacing with 0 and 1
    final_data['RenalDiseaseIndicator'] = final_data['RenalDiseaseIndicator'].map({'Y':1,'0':0})
    final_data['ChronicCond_Alzheimer'] = final_data['ChronicCond_Alzheimer'].map({2:0,1:1})
    final_data['ChronicCond_Heartfailure'] = final_data['ChronicCond_Heartfailure'].map({2:0,1:1})
    final_data['ChronicCond_KidneyDisease'] = final_data['ChronicCond_KidneyDisease'].map({2:0,1:1}
)
    final_data['ChronicCond_Cancer'] = final_data['ChronicCond_Cancer'].map({2:0,1:1})
    final_data['ChronicCond_ObstrPulmonary'] = final_data['ChronicCond_ObstrPulmonary'].map({2:0,1:
1})
    final_data['ChronicCond_Depression'] = final_data['ChronicCond_Depression'].map({2:0,1:1})
    final_data['ChronicCond_Diabetes'] = final_data['ChronicCond_Diabetes'].map({2:0,1:1})
    final_data['ChronicCond_IschemicHeart'] = final_data['ChronicCond_IschemicHeart'].map({2:0,1:1}
)
    final_data['ChronicCond_Osteoporasis'] = final_data['ChronicCond_Osteoporasis'].map({2:0,1:1})
    final_data['ChronicCond_rheumatoidarthritis'] = final_data['ChronicCond_rheumatoidarthritis'].m
ap({2:0,1:1})
    final_data['ChronicCond_stroke'] = final_data['ChronicCond_stroke'].map({2:0,1:1})
    final_data['Gender'] = final_data['Gender'].map({2:0,1:1})
    print('data preprocessing done...')

    ## featurization

    ## counting num of times patient made claim
    bene_count = final_data['BeneID'].value_counts().to_dict()
    final_data['BeneCount'] = final_data['BeneID'].map(bene_count)

    ## counting num of times provider covered claim
    pro_count = final_data['Provider'].value_counts().to_dict()
    final_data['ProviderCount'] = final_data['Provider'].map(pro_count)

    ## counting num of times physician attended all patient
    attphy_count = final_data['AttendingPhysician'].value_counts().to_dict()
    final_data['AttendingPhysicianCount'] = final_data['AttendingPhysician'].map(attphy_count)
    ## replacing null with 0
    final_data['AttendingPhysicianCount'] = final_data['AttendingPhysicianCount'].fillna(0)

    ## num of days patient admitted

    ## converting non-null object type of dt column to datetime
    final_data['AdmissionDt']= pd.to_datetime(final_data['AdmissionDt'])
    final_data['DischargeDt']= pd.to_datetime(final_data['DischargeDt'])
    final_data['ClaimStartDt']= pd.to_datetime(final_data['ClaimStartDt'])
    final_data['ClaimEndDt']= pd.to_datetime(final_data['ClaimEndDt'])

    final_data['numOfDaysAdmitted'] = final_data['DischargeDt'] - final_data['AdmissionDt']
    ## filling na with 0
    final_data['numOfDaysAdmitted'] = final_data['numOfDaysAdmitted'].fillna(0)
    ## converting days type to int
    final_data['numOfDaysAdmitted'] = final_data['numOfDaysAdmitted'].dt.days.astype('int64')

    ## num of days for claim took to reimbursed
```

```
    final_data['numOfDaysForClaim'] = final_data['ClaimEndDt'] - final_data['ClaimStartDt']
    ## filling na with 0
    final_data['numOfDaysForClaim'] = final_data['numOfDaysForClaim'].fillna(0)
    ## converting days type to int
    final_data['numOfDaysForClaim'] = final_data['numOfDaysForClaim'].dt.days.astype('int64')

    ## calculating total ip,op amount reimburse

    ## adding ip op amount
    ip_op_total_amount = final_data['IPAnnualReimbursementAmt'] +
final_data['OPAnnualReimbursementAmt']
    ## adding deductible amount
    ip_op_ded_amount = final_data['IPAnnualDeductibleAmt'] + final_data['OPAnnualDeductibleAmt']
    ## total amount - deductible amount
    ip_op_total_amount = ip_op_total_amount - ip_op_ded_amount
    final_data['ip_op_total_amount'] = ip_op_total_amount

    ## calculating total disease patient was diagnosed before

    num_of_chronic = final_data['RenalDiseaseIndicator'] + final_data['ChronicCond_Alzheimer'] + \
                     final_data['ChronicCond_Heartfailure'] + final_data['ChronicCond_KidneyDisease'
] + \
                     final_data['ChronicCond_Cancer'] + final_data['ChronicCond_ObstrPulmonary'] + \
                     final_data['ChronicCond_Depression'] + final_data['ChronicCond_Diabetes'] + \
                     final_data['ChronicCond_IschemicHeart'] + final_data['ChronicCond_Osteoporasis'
] + \
                     final_data['ChronicCond_rheumatoidarthritis'] + final_data['ChronicCond_stroke'
]
    final_data['num_of_chronic'] = num_of_chronic

    ## calculating num of diagnosis procedure undergonw by patient

    num_of_diag_proc = final_data[['ClmDiagnosisCode_1', 'ClmDiagnosisCode_2',
'ClmDiagnosisCode_3',
       'ClmDiagnosisCode_4', 'ClmDiagnosisCode_5', 'ClmDiagnosisCode_6',
       'ClmDiagnosisCode_7', 'ClmDiagnosisCode_8', 'ClmDiagnosisCode_9',
       'ClmDiagnosisCode_10', 'ClmProcedureCode_1', 'ClmProcedureCode_2',
       'ClmProcedureCode_3', 'ClmProcedureCode_4',
       'DiagnosisGroupCode','ClmAdmitDiagnosisCode']].values

    ## counting non zero value in each row
    countnum_of_diag_proc = []
    for i in range(len(num_of_diag_proc)):
        countnum_of_diag_proc.append(np.count_nonzero(num_of_diag_proc[i]))
    final_data['num_of_diag_proc'] = countnum_of_diag_proc

    ## calculating num of physician treating patient

    num_of_phy = final_data[['AttendingPhysician','OperatingPhysician','OtherPhysician']].fillna(0)
.values
    countnum_of_phy = []
    for i in range(len(num_of_phy)):
        countnum_of_phy.append(np.count_nonzero(num_of_phy[i]))

    final_data['num_of_phy'] = countnum_of_phy

    ## one hot encoding diagnosis code

    top10 = ['4019','25000','2724','V5869','4011','42731','V5861','2720','2449','4280']
    for col in top10:
        final_data['diagnosis_'+str(col)] = np.where(final_data['ClmDiagnosisCode_1']==col,1,0)
        final_data['diagnosis_'+str(col)] = np.where(final_data['ClmDiagnosisCode_2']==col,1,\
                                        np.where(final_data['diagnosis_'+str(col)]==1,1,0 ))
        final_data['diagnosis_'+str(col)] = np.where(final_data['ClmDiagnosisCode_3']==col,1,\
                                        np.where(final_data['diagnosis_'+str(col)]==1,1,0 ))
        final_data['diagnosis_'+str(col)] = np.where(final_data['ClmDiagnosisCode_4']==col,1,\
                                        np.where(final_data['diagnosis_'+str(col)]==1,1,0 ))
        final_data['diagnosis_'+str(col)] = np.where(final_data['ClmDiagnosisCode_5']==col,1,\
                                        np.where(final_data['diagnosis_'+str(col)]==1,1,0 ))
        final_data['diagnosis_'+str(col)] = np.where(final_data['ClmDiagnosisCode_6']==col,1,\
                                        np.where(final_data['diagnosis_'+str(col)]==1,1,0 ))
        final_data['diagnosis_'+str(col)] = np.where(final_data['ClmDiagnosisCode_7']==col,1,\
                                        np.where(final_data['diagnosis_'+str(col)]==1,1,0 ))
        final_data['diagnosis_'+str(col)] = np.where(final_data['ClmDiagnosisCode_8']==col,1,\
                                        np.where(final_data['diagnosis_'+str(col)]==1,1,0 ))
        final_data['diagnosis_'+str(col)] = np.where(final_data['ClmDiagnosisCode_9']==col,1,\
                                        np.where(final_data['diagnosis_'+str(col)]==1,1,0 ))
```

```
        final_data['diagnosis_'+str(col)] = np.where(final_data['ClmDiagnosisCode_10']==col,1,\
                                        np.where(final_data['diagnosis_'+str(col)]==1,1,0 ))
        final_data['diagnosis_'+str(col)] = np.where(final_data['DiagnosisGroupCode']==col,1,\
                                        np.where(final_data['diagnosis_'+str(col)]==1,1,0 ))
        final_data['diagnosis_'+str(col)] = np.where(final_data['ClmAdmitDiagnosisCode']==col,1,\
                                        np.where(final_data['diagnosis_'+str(col)]==1,1,0 ))

    ## one hot encoding procedure code

    top5 = [4019.0, 9904.0, 2724.0, 8154.0, 66.0]
    for col in top5:
        final_data['procedure_'+str(col)] = np.where(final_data['ClmProcedureCode_1']==col,1,0)
        final_data['procedure_'+str(col)] = np.where(final_data['ClmProcedureCode_2']==col,1,\
                                        np.where(final_data['procedure_'+str(col)]==1,1,0 ))
        final_data['procedure_'+str(col)] = np.where(final_data['ClmProcedureCode_3']==col,1,\
                                        np.where(final_data['procedure_'+str(col)]==1,1,0 ))
        final_data['procedure_'+str(col)] = np.where(final_data['ClmProcedureCode_4']==col,1,\
                                        np.where(final_data['procedure_'+str(col)]==1,1,0 ))

    ## frequency encoding diagnosis, procedure code

    DiagnosisCode_1_count = final_data['ClmDiagnosisCode_1'].value_counts().to_dict()
    DiagnosisCode_1_count[0]=0
    DiagnosisCode_2_count = final_data['ClmDiagnosisCode_2'].value_counts().to_dict()
    DiagnosisCode_2_count[0]=0
    DiagnosisCode_3_count = final_data['ClmDiagnosisCode_3'].value_counts().to_dict()
    DiagnosisCode_3_count[0]=0
    DiagnosisCode_4_count = final_data['ClmDiagnosisCode_4'].value_counts().to_dict()
    DiagnosisCode_4_count[0]=0
    DiagnosisCode_5_count = final_data['ClmDiagnosisCode_5'].value_counts().to_dict()
    DiagnosisCode_5_count[0]=0
    DiagnosisCode_6_count = final_data['ClmDiagnosisCode_6'].value_counts().to_dict()
    DiagnosisCode_6_count[0]=0
    DiagnosisCode_7_count = final_data['ClmDiagnosisCode_7'].value_counts().to_dict()
    DiagnosisCode_7_count[0]=0
    DiagnosisCode_8_count = final_data['ClmDiagnosisCode_8'].value_counts().to_dict()
    DiagnosisCode_8_count[0]=0
    DiagnosisCode_9_count = final_data['ClmDiagnosisCode_9'].value_counts().to_dict()
    DiagnosisCode_9_count[0]=0
    DiagnosisCode_10_count = final_data['ClmDiagnosisCode_10'].value_counts().to_dict()
    DiagnosisCode_10_count[0]=0
    ClmAdmitDiagnosisCode_count = final_data['ClmAdmitDiagnosisCode'].value_counts().to_dict()
    ClmAdmitDiagnosisCode_count[0]=0
    DiagnosisGroupCode_count = final_data['DiagnosisGroupCode'].value_counts().to_dict()
    DiagnosisGroupCode_count[0]=0

    final_data['DiagnosisCode_1_count'] =
final_data['ClmDiagnosisCode_1'].map(DiagnosisCode_1_count)
    final_data['DiagnosisCode_2_count'] =
final_data['ClmDiagnosisCode_2'].map(DiagnosisCode_2_count)
    final_data['DiagnosisCode_3_count'] =
final_data['ClmDiagnosisCode_3'].map(DiagnosisCode_3_count)
    final_data['DiagnosisCode_4_count'] =
final_data['ClmDiagnosisCode_4'].map(DiagnosisCode_4_count)
    final_data['DiagnosisCode_5_count'] =
final_data['ClmDiagnosisCode_5'].map(DiagnosisCode_5_count)
    final_data['DiagnosisCode_6_count'] =
final_data['ClmDiagnosisCode_6'].map(DiagnosisCode_6_count)
    final_data['DiagnosisCode_7_count'] =
final_data['ClmDiagnosisCode_7'].map(DiagnosisCode_7_count)
    final_data['DiagnosisCode_8_count'] =
final_data['ClmDiagnosisCode_8'].map(DiagnosisCode_8_count)
    final_data['DiagnosisCode_9_count'] =
final_data['ClmDiagnosisCode_9'].map(DiagnosisCode_9_count)
    final_data['DiagnosisCode_10_count'] =
final_data['ClmDiagnosisCode_10'].map(DiagnosisCode_10_count)
    final_data['ClmAdmitDiagnosisCode_count'] = final_data['ClmAdmitDiagnosisCode'].map(ClmAdmitDia
gnosisCode_count)
    final_data['DiagnosisGroupCode_count'] = final_data['DiagnosisGroupCode'].map(DiagnosisGroupCod
e_count)
    print('featurization done...')

    ## dropping col after featurization

    provider = final_data['Provider'].values

    final_data = final_data.drop(['BeneID', 'ClaimID', 'ClaimStartDt', 'ClaimEndDt', 'Provider','At
```

```
tendingPhysician', 'OperatingPhysician',
       'OtherPhysician', 'AdmissionDt','ClmAdmitDiagnosisCode','DischargeDt', 'DiagnosisGroupCode',
       'ClmDiagnosisCode_1', 'ClmDiagnosisCode_2', 'ClmDiagnosisCode_3',
       'ClmDiagnosisCode_4', 'ClmDiagnosisCode_5', 'ClmDiagnosisCode_6',
       'ClmDiagnosisCode_7', 'ClmDiagnosisCode_8', 'ClmDiagnosisCode_9',
       'ClmDiagnosisCode_10', 'ClmProcedureCode_1', 'ClmProcedureCode_2',
       'ClmProcedureCode_3', 'ClmProcedureCode_4','DOB', 'DOD'],axis=1)

    final_data.to_csv('final_test_data_feature.csv')

    ## normalizing using min max scalar

    min_max_scaler = preprocessing.MinMaxScaler()
    def min_max(data,column):
        """ scaling column value using min max scalar, fitting on train and transforming """
        min_max_scaler.fit(data[column].values.reshape(-1,1))
        data_scale = min_max_scaler.transform(data[column].values.reshape(-1,1))
        return data_scale

    ## col to normalize
    col_to_nor = ['InscClaimAmtReimbursed', 'DeductibleAmtPaid', 'Race',
           'State', 'County', 'IPAnnualReimbursementAmt', 'IPAnnualDeductibleAmt',
           'OPAnnualReimbursementAmt', 'OPAnnualDeductibleAmt', 'BeneCount',
           'ProviderCount', 'AttendingPhysicianCount', 'numOfDaysAdmitted',
           'numOfDaysForClaim', 'ip_op_total_amount', 'num_of_chronic',
           'num_of_diag_proc', 'num_of_phy', 'DiagnosisCode_1_count', 'DiagnosisCode_2_count',
           'DiagnosisCode_3_count', 'DiagnosisCode_4_count',
           'DiagnosisCode_5_count', 'DiagnosisCode_6_count',
           'DiagnosisCode_7_count', 'DiagnosisCode_8_count',
           'DiagnosisCode_9_count', 'DiagnosisCode_10_count',
           'ClmAdmitDiagnosisCode_count', 'DiagnosisGroupCode_count']
    for i in col_to_nor:
        data_scale = min_max(final_data,i)
        final_data[i] = data_scale
    print('normalizing done...')

    ## loading model

    def predict_using_best_threshold(probability, threshold):
        """ convert proba value using best threshold """
        predictions = []
        for i in probability:
            if i>=threshold:
                predictions.append(1)
            else:
                predictions.append(0)
        return predictions

    model = joblib.load('xgb_tuned_on_0.pkl')
    print('loading model done...')

    y_pred = model.predict_proba(final_data)[:,1]
    pred_on_best_threshold = predict_using_best_threshold(y_pred, threshold = 0.2092)

    prediction = pd.DataFrame()
    prediction['providerID'] = provider
    prediction['predictions'] = pred_on_best_threshold
    print('prediction done...')

    return prediction
```

In [12]:

```
prediction_on_test= final(X)
print(prediction_on_test)
```

```
all file merged...
data preprocessing done...
featurization done...
normalizing done...
loading model done...
prediction done...
       providerID  predictions
0        PRV57070            0
1        PRV57070            1
```

```
2         PRV57070            0
3         PRV57070            1
4         PRV57070            1
5         PRV57070            1
6         PRV57070            1
7         PRV57070            1
8         PRV57070            1
9         PRV57070            0
10        PRV57070            1
11        PRV57070            1
12        PRV56558            1
13        PRV56558            1
14        PRV56558            1
15        PRV56558            1
16        PRV56558            1
17        PRV56558            1
18        PRV56558            1
19        PRV56558            1
20        PRV56558            1
21        PRV56558            1
22        PRV56558            1
23        PRV56558            1
24        PRV56558            1
25        PRV56558            1
26        PRV56558            1
27        PRV56558            1
28        PRV56558            1
29        PRV56558            1
...           ...          ...
135362    PRV53737            0
135363    PRV53737            0
135364    PRV51659            0
135365    PRV51659            0
135366    PRV51659            0
135367    PRV51659            0
135368    PRV53557            0
135369    PRV54791            0
135370    PRV54791            0
135371    PRV52620            0
135372    PRV52620            0
135373    PRV56192            0
135374    PRV56192            0
135375    PRV51728            0
135376    PRV51728            0
135377    PRV51728            0
135378    PRV56619            0
135379    PRV56082            0
135380    PRV54169            0
135381    PRV56325            0
135382    PRV57628            0
135383    PRV52776            0
135384    PRV54613            0
135385    PRV56372            0
135386    PRV56372            0
135387    PRV54617            0
135388    PRV53736            0
135389    PRV53736            0
135390    PRV53089            0
135391    PRV55336            0

[135392 rows x 2 columns]
```

In [14]:

```
## file with null filled with 0

final_data_test = pd.read_csv('final_data_feature.csv')
final_data_test.drop('Unnamed: 0',axis=1,inplace=True)
```

In [15]:

```
from sklearn.model_selection import train_test_split
train, test = train_test_split(final_data_test, test_size=0.20,random_state=0)
```

In [17]:

```
Y = test['PotentialFraud']
X = test.drop('PotentialFraud', axis=1)
```

In [19]:

```
X.shape
```

Out[19]:

```
(111643, 58)
```

In [23]:

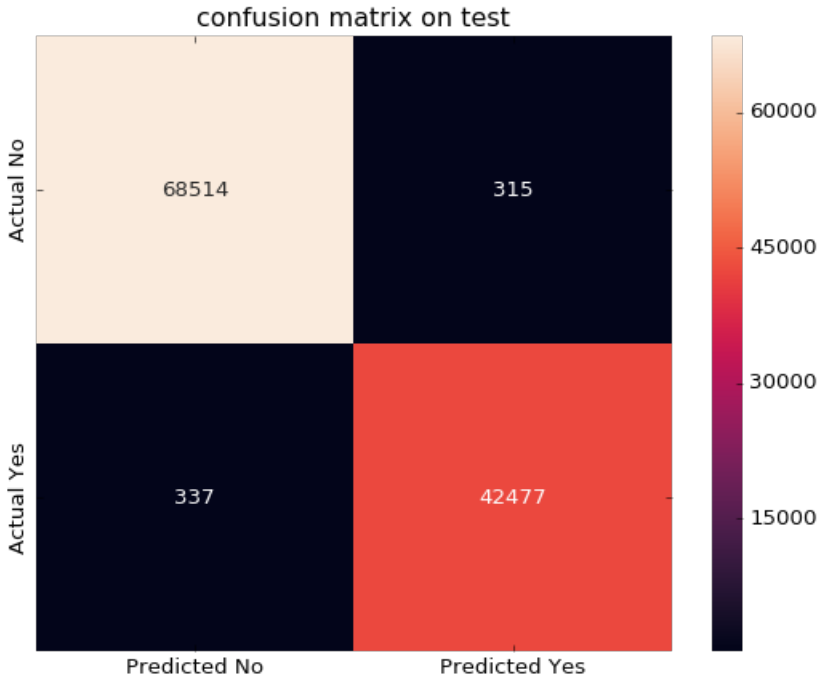
```
def performance(X,Y):
    """ take input test and predict on trained model and check model performance"""

    ## normalizing using min max scalar

    min_max_scaler = preprocessing.MinMaxScaler()
    def min_max(data,column):
        """ scaling column value using min max scalar, fitting on train and transforming """
        min_max_scaler.fit(data[column].values.reshape(-1,1))
        data_scale = min_max_scaler.transform(data[column].values.reshape(-1,1))
        return data_scale

    ## col to normalize
    col_to_nor = ['InscClaimAmtReimbursed', 'DeductibleAmtPaid', 'Race',
           'State', 'County', 'IPAnnualReimbursementAmt', 'IPAnnualDeductibleAmt',
           'OPAnnualReimbursementAmt', 'OPAnnualDeductibleAmt', 'BeneCount',
           'ProviderCount', 'AttendingPhysicianCount', 'numOfDaysAdmitted',
           'numOfDaysForClaim', 'ip_op_total_amount', 'num_of_chronic',
           'num_of_diag_proc', 'num_of_phy', 'DiagnosisCode_1_count', 'DiagnosisCode_2_count',
           'DiagnosisCode_3_count', 'DiagnosisCode_4_count',
           'DiagnosisCode_5_count', 'DiagnosisCode_6_count',
           'DiagnosisCode_7_count', 'DiagnosisCode_8_count',
           'DiagnosisCode_9_count', 'DiagnosisCode_10_count',
           'ClmAdmitDiagnosisCode_count', 'DiagnosisGroupCode_count']
    for i in col_to_nor:
        data_scale = min_max(X,i)
        X[i] = data_scale

     ## loading model

    def predict_using_best_threshold(probability, threshold):
        """ convert proba value using best threshold """
        predictions = []
        for i in probability:
            if i>=threshold:
                predictions.append(1)
            else:
                predictions.append(0)
        return predictions

    def plot_confusion_matrix(model,X,Y,threshold):
        """ ploting confusion matrix using best threshold """
        ## fpr,tpr,threshold
        y_pred = model.predict_proba(X)[:,1]
        fpr,tpr,thresholds = roc_curve(Y, y_pred)

        ## confusion matrix
        test_conmat = confusion_matrix(Y, predict_using_best_threshold(y_pred, threshold))

        sns.heatmap(test_conmat,xticklabels=['Predicted No','Predicted Yes'],yticklabels=['Actual N
o','Actual Yes'],annot=True,fmt='d')
        plt.title('confusion matrix on test')
        plt.show()

    def f1(model,X,Y,threshold):
        """ calculate f1, macro f1 score """
        y_pred = model.predict_proba(X)[:,1]
        fpr,tpr,thresholds = roc_curve(Y, y_pred)

        f1_test = f1_score(Y, predict_using_best_threshold(y_pred, threshold))
```

```
        macro_f1_test = f1_score(Y, predict_using_best_threshold(y_pred, threshold),average='macro'
)

        return f1_test,macro_f1_test

    model = joblib.load('xgb_tuned_on_0.pkl')
    print('loading model done...')

    y_pred = model.predict_proba(X)[:,1]
    pred_on_best_threshold = predict_using_best_threshold(y_pred, 0.2092)

    plot_confusion_matrix(model,X,Y,0.2092)
    f1,macro_f1 = f1(model,X,Y,0.2092)
    print('f1 score :',f1)
    print('macro f1 score :',macro_f1)

    prediction = pd.DataFrame()
    prediction['actual_Y'] = Y
    prediction['predictions'] = pred_on_best_threshold
    print('prediction done...')

    return prediction
```

In [24]:

```
model_performance = performance(X,Y)
print(model_performance)
```

```
loading model done...
```




```
f1 score : 0.992383711422
macro f1 score : 0.993824046298
prediction done...
        actual_Y  predictions
368022         0            0
347889         0            0
6731           1            1
371099         0            0
487726         0            0
270660         1            1
453174         0            0
420316         0            0
334583         0            0
```

| | | |
|---|---|---|
| 319996 | 1 | 1 |
| 120196 | 1 | 1 |
| 150101 | 0 | 0 |
| 204402 | 0 | 0 |
| 6665 | 1 | 1 |
| 210765 | 1 | 1 |
| 76439 | 0 | 0 |
| 128651 | 1 | 1 |
| 119971 | 1 | 1 |
| 268372 | 1 | 1 |
| 433588 | 0 | 0 |
| 287115 | 1 | 1 |
| 99422 | 1 | 1 |
| 205597 | 0 | 0 |
| 212789 | 1 | 1 |
| 415365 | 0 | 0 |
| 398477 | 0 | 0 |
| 432463 | 1 | 1 |
| 336770 | 0 | 0 |
| 473996 | 0 | 0 |
| 433572 | 0 | 0 |
| ... | ... | ... |
| 125085 | 1 | 1 |
| 516734 | 0 | 0 |
| 495158 | 0 | 0 |
| 450271 | 0 | 0 |
| 294811 | 0 | 0 |
| 436077 | 0 | 0 |
| 32293 | 1 | 1 |
| 367910 | 0 | 0 |
| 415508 | 0 | 0 |
| 393524 | 0 | 0 |
| 279290 | 1 | 1 |
| 443780 | 1 | 1 |
| 101359 | 0 | 0 |
| 501260 | 0 | 0 |
| 300732 | 1 | 1 |
| 297609 | 0 | 0 |
| 483147 | 0 | 0 |
| 151583 | 1 | 1 |
| 310379 | 1 | 1 |
| 21337 | 1 | 1 |
| 38649 | 1 | 1 |
| 422069 | 0 | 0 |
| 140751 | 1 | 1 |
| 390808 | 1 | 1 |
| 299621 | 0 | 0 |
| 538252 | 0 | 0 |
| 216964 | 1 | 1 |
| 36254 | 0 | 0 |
| 386387 | 0 | 0 |
| 119136 | 0 | 0 |

[111643 rows x 2 columns]

In [ ]: